GAS JOURNAL, SEPT. 4, 1946

VOL. 248 98th YEAR No. 4346

DISTRICT HEATING

IN our issue last week we referred to some of the aspects of the final report of the New Towns Committee. It did not surprise us to find that the Committee had something to say on the subject of district heating. Indeed to our mind undue prominence is given to district heating. There is in existence a District Heating Sub-Committee of the Heating and Ventilation (Reconstruction) Committee of the D.S.I.R., which has been sitting for some years to consider the subject of district heating. It would seem from internal evidence in the report that the Reith Committee has consulted only this body in regard to district heating and has accepted its conclusions without question. These conclusions, when they are published, may be found to be sound; but as they have not been published as yet we cannot express an opinion. Such internal evidence as we have in this report, however, suggests that there is a good deal more to be considered than is contained in the evidence that this particular Sub-Committee has put before the Reith Committee. Although we shall not deal here with the subject of district heating with any completeness, it is well that some attention should be called to the report of this Committee.

It is laid down that "there are obvious advantages in central generation of heating, by whatever means, both to the individual and to the community." This sentence by itself is unexceptionable because it applies equally to the gas-works and the electricity generating station. In its context, however, it appears to relate primarily to the supply of hot water or steam for domestic, commercial, or industrial use. We are not by any means as certain as the Committee appears to be that there are obvious advantages in the central generation of hot water or steam which has then to be distributed over a very considerable area and which, moreover, can only be economically distributed over a densely populated area for which the distribution costs for any fuel would be the minimum.

There is a possible advantage, which the advocates of district heating make the most of, in the fact that by generation in a central plant low grade fuels can be burnt. The favourable economics of any district heating scheme appear to depend on the supposition that low grade fuel can be bought at low prices. If the district heating scheme had to pay the same costs for coal as a gas undertaking, for example, the cost of the heat service would rise considerably. We should like some further information from the National Coal Board, when it has got itself organized, as to the supply of low grade fuel and as to the need for finding a use for it. A certain minimum quantity of low grade fuel must always be produced for which a use must be found. Coke breeze is one of these unfortunate fuels. Slurries and intermediates from coal washing plants at collieries are also on the list, but the cost of transport of ash is such that in general it is considered desirable to use low grade fuels at or very near the place of production. As the Coal Board becomes organized it is likely that more coal cleaning plants will be installed, so that when low grade fuels are produced they will be produced in moderate quantities and will presumably be used at the colliery. There will be many industrial firms who can put in plants specifically for the use of low grade coal when supplies are guaranteed at a stated price over a period of years. A good deal has been written about using low grade fuel in industry. It is our conviction that the solution of the problem lies first in its production in known quantities, secondly in a stable price structure, and thirdly in the design of the plant in which it is to be used. We do not consider that the use of low grade fuel should properly be regarded as a specific advantage of district heating.

The Committee, however, goes further than this. It suggests that central plants for the provision of steam and hot water "minimize smoke emission and reduce costs and allow convenience for fuel transport and distribution. Other advantages are the reduction of labour and dirt, saving of chimneys and flues, and economy in house building." We are surprised to find the Committee apparently recommending that new houses may not have chimneys or flues. Some ventilation will be required. Chimneys with flues should be built into new houses in order that the consumer is not compelled to rely on hot water from the district scheme for space heating. In practically every other section of the report there is recognition that the man who lives in the town must be allowed choice as to the conditions under which he wishes to live. The Committee believes that there will be an ever-increasing demand for central heating. That may be so, but while some background heating may be desirable and could be supplied by a district heating scheme, the damp and foggy conditions of this country, which are quite different from the Continental climate of the U.S.A. and Europe, seem to make some form of high temperature heat desirable and necessary. The Committee agrees that most householders will want an open fire in one room and they see no objection to this "if smokeless fuel and a modern design of grate are used." High temperature heat is essential also for cooking.

An appendix is devoted to district heating which appears to have been provided by the Sub-Committee on district heating to which reference has been made earlier. Unfortunately neither in this appendix nor in the body of the report is there any recognition of the fact that the whole basis of district heating is that it shall be given the cream of the supply area. While the gas-works and the electricity station are to be situated in the industrial part of the town the central district heating plants would be placed in those positions where they would operate to the best advantage. There are certain densities of population within which district heating claims a monopoly of such heat as can be supplied by radiators and hot water. The consumption per consumer for gas heating in these houses would be reduced to a very small fraction of what it is to-day or what it might be with a modern heating service. On the other hand where, towards the outskirts of the town, it would not appear to be economic to install district heating, gas and electricity would be expected to step into the breach and take the full load. Fundamental weaknesses of the case for district heating are that it demands a monopoly over other sources of heat over the cream of the area, and it reduces the consumption per consumer for other sources of heat drastically. The result can only be a substantially increased cost of gas, coke, and electricity throughout the area, and the total financial cost of heat and power services to the individual citizen will be increased

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even though the cost per therm of district heating may be lower.

The primary justification for district heating would be its use to improve the efficiency of electrical generating stations through the economic utilization of the heat rejected from the generating plant. This would be a matter of very great difficulty in its application to existing stations since the entire electrical generating plant would have to be rebuilt. Quite rightly the Committee states that " unless an electricity station happens to be favourably situated in relation to the potential heat load, or unless there is a suitable site on which it would be convenient to develop a new thermal electric station, it would be necessary to develop district heating on a purely thermal basis." We do not at the moment see any enthusiasm on the part of the electricity industry to take advantage of the increase in overall efficiency which would be theoretically obtained by the application of district heating to power station practice.

We have devoted considerable space to considering the Committee's notes on district heating, because, while exercising a wise discretion in regard to the use of other forms of heating, it has gone out of its way to sponsor the idea that one at least of the new towns should be designed for this particular method of supplying hot water. The appendix contains a curious mixture of supposition and computation based on hearsay evidence gleaned in papers—one at least of which is anonymous—on the cost of supplying a therm in the form of hot water. There is no parallel appraisement of the cost of supplying a therm of coke or of gas. There is no evidence that the volume of opinion adverse to district heating has been heard or considered. It is admitted that only in certain circumstances can district heating be justified economically. But the whole basis of the discussion should not be to decide under what conditions can a particular form of heat be used with advantage, but under what conditions the consumer will get the best and cheapest service. We cannot see any evidence that the wide problem has been considered. Will the borough surveyor welcome yet another addition to his overloaded basement under the roads ? The Committee agrees that existing services will be seriously congested in narrow roads (less than 10 ft. 6 in. must be allowed on each side of the street), and then goes on to state that district heating mains " must be carried in special ducts, and these should be kept separate from other services. Where the footway and verge are over 10 ft. 6 in. wide sufficient space may be available beneath the verge. Otherwise it will be necessary for them to be under the carriageway." One can visualize considerable leakage and repair charges.

Diary

Sept. 9.—Women's Gas Council Executive Committee, Gas Industry House.

Sept. 10.—B.G.C.: Meeting at Gas Industry House, 2.30 p.m.

Sept. 10.—National Federation of Gas Coke Associations: General Committee, 10 a.m., Gas Industry House.

Sept. 10-12.—Association of Public Lighting Engineers: Annual Conference and Exhibition of Street Lighting Apparatus and Equipment. Central Hall, Westminster. Opening by the Right Hon. Alfred Barnes, Minister of Transport (Sept. 10), 11 a.m.

Sept. 11.—Domestic Development Committee, Gas Industry House, 2.30 p.m.

Sept. 11.—British Association of Chemists: " The Factory Acts as they Affect Chemists," J. S. Evans, B.A., B.Sc., H.M. Inspector of Factories, Engineering and Chemical Branch. Gas Industry House, 7 p.m.

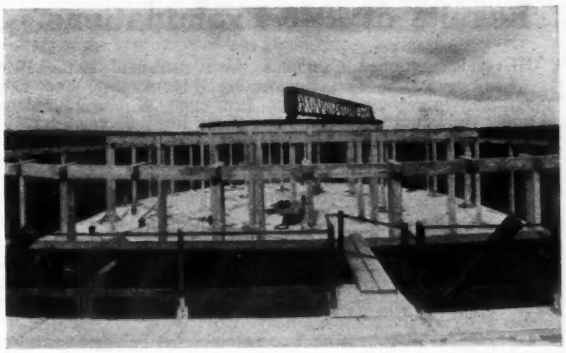
Sept. 12.—North British Association of Gas Managers: Annual General Meeting at Rothesay.

Sept. 16.—London and Counties Coke Association: Finance Committee, 11 a.m.; Executive Committee, 11.30 a.m.; Central Committee, 1.30 p.m.; Gas Industry House.

Oct. 11.—National Federation of Gas Coke Associations: National Technical Committee, Gas Industry House, 10.30 a.m.

Oct. 11.—Solid Smokeless Fuels Federation Technical Committee, Gas Industry House, 2.30 p.m.

New Features in Tank Construction



Reinforced concrete gasholder tank under construction for the Newcastle-upon-Tyne and Gateshead Gas Company at South Gosforth. Specially designed by F.C. Construction Co., Ltd., Derby, the tank has a water capacity of 5,000,000 *gal. and embodies some entirely new features*

New features have been tried out for the first time in this country in the construction of a new gasholder tank at South Gosforth the the Newcastle-upon-Tyne and Gateshead Gas Company. The tank, which holds 5,000,000 gal. of water for sealing purposes, was designed by the F.C. Construction Co., Ltd., to house a three lift telescopic gasholder of 3,000,000 cu.ft. capacity in a manner which would permit of a minimum use of steel in the construction of the actual holder.

This object has been effected by employing a fixed framing consisting of three polygonal rings of reinforced concrete beams and columns in the centre of the tank to provide a support for the crown of the holder when fully lowered. In this way it has been made possible to dispense with the extra steel which would have been needed for a self-supporting crown. Another feature of the design was the use of permanent brick shuttering for the outer retaining walls of the tank, which has an internal diameter of 216 ft. and a depth of 31 ft. 9 in. As sufficient timber shuttering could not be obtained for such a large-scale undertaking, it was decided to build an outer shell wall of 4½ in. brick and an inner wall of 9 in. brickwork.

The inner wall was waterproofed on the convex face by Callenderite sheeting which was heated on and then given a cement rendering. Excavated material has been banked against the outer retaining wall, which rises 14 ft. above ground level, at a 2 to 1 gradient to give added strength.

The walls stand on a reinforced concrete ring footing 11 ft. 3 in. wide and 1 ft. 6 in. thick and rise from 2 ft. in width at the base to 1 ft. at the coping with three intermediate steps. The floor of the tank is sloped upward at an angle of 20° towards a central crown and covered with reinforced slabs 15 ft. by 15 ft. and 6 in. thick, which were cast *in situ*. The whole of the concrete work was carried out by Messrs. Wimpey & Co.

Owing to Government height restrictions the original intention to erect a four-lift holder with an overall inflated height of 170 ft. had to scrapped in favour of the present scheme in which the holder will rise to a maximum permitted height of 110 ft. above ground level.

In the construction of the all-welded gasholder further steel saving was effected by a patent method of applying the steel plates diagonally, thus giving lateral strength to the structure without extra bracing being necessary. The contractors for the steelwork were the Oxley Engineering Co., Ltd., of Leeds. To reduce evaporation of the sealing water, oil will be poured on its surface and anti-freezing devices have been installed.

The Functions of a new patented compensating cam in the " Wilson " Mk. V Bicoin Attachment for prepayment meters are described in a leaflet issued by George Wilson Gas Meters, Ltd. The compensating cam is a successor to the compensating spring device and is designed, among other purposes, to enable the supply of gas to a refrigerator or other low consumption appliance to be maintained even though the meter is short of coins.

Refresher Courses for Industrial Designers have been organized by the Central Institute of Art and Design. Their purpose is to keep designers who have been away from industry on war service in touch with current trends of design in this country. The courses cover the field of design in a number of industries, including cutlery, pottery, glass, wallpaper and interior decoration. They will include lectures by authorities in various aspects of design and visits to art exhibitions, factories, shops, and museums. Full particulars may be obtained from the Institute at the National Gallery, Trafalgar Square, S.W.1.

Institution of Gas Engineers

Results of 1946 Examinations

THE undermentioned Candidates were successful in the 1946 Examinations in Gas Engineering (Manufacture) and Gas Engineering (Supply) of the Institution of Gas Engineers, held under the Education Regulations of the Institution.

EXTERNAL CANDIDATES (51)

Diploma in Gas Engineering (Manufacture) (8)

Class	Name	Town
First	Barker, F. C.	Coventry
"	Cole, A.	Bradford
Second	Ellis, F. C.	Torquay
"	Foulds, R. W.	Carlisle
"	Jarrett, L. W.	Rushden
"	Seager, A. C.	Southend-on-Sea
"	Spiller, W. J.	Cambridge
"	Wicks, T. R.	Workington

Higher Grade Certificate in Gas Engineering (Manufacture) (10)

Class	Name	Town
First	Forbes, P. C.	Ware
"	Yates, A.	Leamington Spa
Second	Ardron, E.	Romsey
"	Bain, J.	London
"	Banks, H. E.	Beverley
"	Beardshaw, W. E.	Dartmouth
"	Chignell, P. A.	London
"	Croxton, H.	Bristol
"	Maunder, D. J.	Paignton
"	Winsor, R. J.	Weston-super-Mare

Ordinary Grade Certificate in Gas Engineering (Manufacture) (17)

Class	Name	Town
Second	Allison, D.	Middlesbrough
"	Blears, D. K.	Darwen
"	Cookson, G. C.	Woolaston
"	Crick, G. C. G.	Newton Abbot
"	Croft, G. L.	Stamford
"	Dalby, H. O.	London
"	Day, J. F.	Newport, Mon.
"	Deathe, P.	Wakefield
"	Foord, P. E.	Eastbourne
"	Hayes, D. H.	Middle East Forces
"	Henderson, P. L.	Norton-on-Tees
"	Johnson, D.	Peterborough
"	Ogden, K. G.	Doncaster
"	Peek, J. F.	Coventry
"	Phillips, D. S.	Wickford
"	Piggott, K. L.	Stonehouse
"	Pollard, R.	Kingston-on-Thames

Diploma in Gas Engineering (Supply) (3)

Class	Name	Town
Second	Foston, R. H.	Torquay
"	Fulton, J. H.	Dumbarton
"	Houston, W. T.	London

Higher Grade Certificate in Gas Engineering (Supply) (7)

Class	Name	Town
First	Brown, W.	Falkirk
Second	Bain, J.	London
"	Cockayne, G. W. F.	Rugby
"	Dyer, A. H.	Newport, Mon.
"	Nelson, S. N. P.	Middlesbrough
"	Spiller, W. J.	Cambridge
"	Taylor, M. H.	Clitheroe

Ordinary Grade Certificate in Gas Engineering (Supply) (5)

Class	Name	Town
First	Tait, S. A.	Hebburn
Second	Ames, B. W.	Margate
"	Barlow, J. C. R.	Stoke-on-Trent
"	Jones, D. G.	Aberystwyth
"	Topp, K. R.	Manchester

Ordinary Grade (Single Subject) Examination in Gas Engineering (Supply) to qualify to sit for the Diploma in Gas Engineering (Manufacture) (1)

Class	Name	Town
First	Robertson, R. W.	Penrith

INTERNAL CANDIDATES (45)

Higher Grade Certificate in Gas Engineering (Manufacture) (13)

Class	Name	Centre
First	Elgin, D. C.	Edinburgh
"	Wood, G. C.	Edinburgh
Second	Alcorn, J.	Glasgow
"	Bateman, M. H.	Huddersfield
"	Garthwaite, A.	Burnley
"	Kay, S. R.	Rotherham
"	Mather, L. R.	Bradford
"	Nicol, L. A.	Glasgow
"	Rendle, F. R.	Plymouth
"	Rudge, F.	Leicester
"	Thomas, D.	Bradford
"	Whitney, W. E.	Birmingham
"	Wood, H. A.	Newcastle-upon-Tyne

Ordinary Grade Certificate in Gas Engineering (Manufacture) (22)

Class	Name	Centre
First	Lowis, J. B.	Harrogate
Second	Bell, R. F.	Glasgow
"	Bown, P. C.	Leicester
"	Clegg, E. B.	Manchester
"	Cole, G. F.	Birmingham
"	Faulkner, P.	Manchester
"	Gamble, J. V.	Leicester
"	Glover, J.	Manchester
"	Hartill, I. J.	Manchester
"	Heap, R. B.	Burnley
"	Ingham, W. S.	Burnley
"	Jones, L. R.	Bristol
"	Kyle, D.	Glasgow
"	McMahon, P. J.	Bristol
"	Needham, K. D.	Manchester
"	O'Shea, J. W.	Leicester
"	Spruce, F. W.	Manchester
"	Thomas, J.	Birmingham
"	Wilkinson, G.	Manchester
"	Wilkinson, H.	Bradford
"	Wilson, B. E.	Bristol
"	Wright, V. R.	Bradford

Higher Grade Certificate in Gas Engineering (Supply) (2)

Class	Name	Centre
Second	Ball, E.	Westminster
"	Campbell, A.	Glasgow

Ordinary Grade Certificate in Gas Engineering (Supply) (6)

Class	Name	Centre
Second	Alcorn, J.	Glasgow
"	Drury, W. R.	Manchester
"	Johnston, W. McM.	Glasgow
"	Pay, J. T.	Middlesbrough
"	Totty, E. A.	Tunstall
"	Unsworth, K.	Manchester

Ordinary Grade (Single Subject) Examination in Gas Engineering Supply) to qualify to sit for the Diploma in Gas Engineering (Manufacture) (2)

Class	Name	Centre
First	Lomax, J.	Bradford
"	Pilling, R.	Manchester

Labour Saving Flats

Three blocks of working-class flats, comprising 56 four-room flats, 48 three-room, 17 two-room and 8 one-room, are being erected by the Finsbury Borough Council on the site of "The New Tunbridge Wells," a former spa with mineral springs used more than 100 years ago. The first block is expected to be ready within a year.

Water will be heated centrally and will pass through a circuit of pipes, heating kitchen tanks and radiators. Built-in gas and electric fires will be provided. For washing, a movable gas-heated copper, which can be stored under the sink, will be installed in each kitchen. Drying will be done partly in the hot cupboard provided in the kitchen and partly on the roof in specially designed shelters. Spacious entrance halls will have perambulator shelters. All flats will have sound insulated floors, and there will be passenger lifts with automatic control and staircases in sound-proof wells.

An unusual feature is the "Garchey" sink, through which all kitchen refuse is disposed of by a water flush beneath the sink and pneumatically drawn into an incinerator.

New Research Laboratories

There was a large gathering at the works of Ashmore, Benson-Pease & Co., Ltd., and the Power-Gas Corporation, Ltd., on the occasion of the opening of new research laboratories on Aug. 23. The ceremony was performed by the Mayor of Stockton-on-Tees, Alderman Alex Ross, who was accompanied by members of the Stockton Corporation Industrial Development Committee.

In commending the firms upon their enterprise and expansion to the laboratories and works, the Mayor mentioned that they were well known as being among the foremost and largest concerns with a world-wide reputation for the design and supply of plant and equipment for the chemical, gas, and iron and steel industries. He pointed out that the laboratories were equipped, not only to serve clients who were installing plant of this description, but also for the purpose of investigating new processes in which they as manufacturing and general contracting engineers became interested.

After an inspection of the laboratories and tour of the Works, the party was entertained to tea by the Managing Director, Mr. N. E. Rambush, and executives of the Companies.

Canadian Sales of manufactured gas by distributing companies during May totalled 2,084,816,000 cu.ft., compared with 2,031,281,000 cu.ft. for the corresponding month last year. Of this amount, 1,226,097,000 cu.ft. were for domestic use, other than house heating; 391,575,000 cu.ft. for industrial use; 343,635,000 cu.ft. for commercial use; 122,324,000 cu.ft. for house heating; and 1,185,000 cu.ft. for other uses. Sales of natural gas during May amounted to 2,166,156,000 cu.ft. The sales figures represent sales by distribution companies to customers; amounts used by producers are not included.

Development of a Gas Grid

Discussion on the Paper by W. Hodkinson (General Manager, United Kingdom Gas Corporation, Ltd.) and H. B. Taylor (General Manager, West Riding Group of Gas Companies) at the Annual Meeting of the Institution of Gas Engineers.

COLONEL W. MONCRIEFF CARR, O.B.E., T.D. (Managing Director, United Kingdom Gas Corporation, Ltd.) (Past-President):—I was responsible for the initiation of the scheme with which Mr. Hodkinson and Mr. Taylor have dealt so ably in the Paper, which has been submitted at the President's request. I would like to take this opportunity to express appreciation, not only of what they have put into the Paper, but of the very great pioneer work which they have done in building up largely from experience—because we have had to feel our way—sound and basic information upon which integration, in so far as the exchange of gas between production plants is concerned, can be worked out.

If the plan which is submitted in the Heyworth Report as a basis for ten regions is to be taken as a sound plan for the integration of the gas undertakings of this country, then I say the recommendations are highly dangerous, and in the long run can only result in dearer gas, because from the point of view of integration it may be said, and I hope it will be said, that whatever plan is ultimately made, no plans of integration will be proceeded with until all the preliminary surveys have been made as to existing efficiencies of production at different points, as to cost of interchange and, most important of all, as to the estimation of the potential loads. That is a big task. The preliminary survey for the West Yorkshire Grid occupied a period of two years.

There were those who thought, and I am afraid the Heyworth Committee as a whole seemed to have formed the impression, that this problem was merely one of drawing lines on paper. If the areas were stated in the first place as planning areas, as a means of setting up the machinery to carry out the survey which is necessary before definite districts for operation are decided upon, then there would be great hope. But I say most definitely that the plan as laid down in the Heyworth Report will be a disastrous one for the consumers and suppliers of gas, if it is proceeded with.

My opinion is based on the experience of the last seven or eight years. I am bound to say that until I, with the assistance of the readers of this Paper, applied myself to the problem I little knew the many difficulties that existed. The problem appears to be a simple one; but those who have studied the paper carefully will realize the many difficulties and limitations that there are in such developments. The Authors have shown that in an industrial area such as this, where there are large numbers of medium size and relatively small undertakings and considerable numbers of distributing points, great economies are possible.

Limitations of Integration

I would like to say one thing about the cost of transmission of gas to-day as compared with the period before the war, when this scheme was initiated. For example, it was our intention, and it would have been possible had it been available then—and if the war had not intervened it would have been available—to convey gas and deliver it into the holders at York, a distance of 22 miles from the existing grid, at slightly less, I think approximately 1½d. per 1,000 cu.ft. less, than the then cost into holders. But to-day, if it were available at the present cost of gas in the grid, it would be more economical to reconstruct and extend the works at York than to effect the link with the grid. I mention that as an indication of the limitations of integration.

There is also a tendency on the part of many people to think that linking up for interchange of gas is going to be of great advantage and assistance to the low-pressure distribution system of the undertakings. That is a very dangerous thought. It cannot be so, except to a very limited extent. I am sure that if you have studied the Paper you will have appreciated the vital importance of load factor in the operation of a grid; the whole economics of that operation are dependent upon load factor. That is proved, I think, by the evidence given in the Paper. The Heyworth Report, in Para. 216, states that amalgamation and integration should give the necessary opportunity for bringing distribution systems up to date. That has a very limited application. Holder stations are necessary at each point of off-take on any grid system serving large numbers of undertakings or large numbers of areas, except where the numbers are very small; and even where the numbers are very small it is essential, from the point of view of the control of the grid, that any discharge from the grid shall be at a constant rate of flow. Unless it is at a constant rate of flow, the whole control and economics of the grid will be upset. In other words, at all times the input and output from the grid must be perfectly balanced, if the grid is to be economic.

Therefore, I say without hesitation that no satsfactory plan can be formulated which is not based on scientific, technical, and commercial investigation of all the factors prior to the commencement of the planning. Coke-oven and gas-works production will both have to play their parts in future integration; and, as the Authors have indicated in their Paper, where you can afford to have a relatively large production close to points of utilization, then large coke-oven production is more economic in relation to a grid system than is small gas-works production.

I repeat the hope that in our future development we may not be led, under nationalization, into the danger of precipating ourselves into schemes which have not been most carefully and scientifically investigated; that must be avoided.

Two Major Problems

Mr. **Norman Hudson** (Mirfield):—Mr. Hodkinson and Mr. Taylor are to be complimented and thanked for having put on record data relating to and a reasoned statement concerning the planning and partial development of a particular gas grid, and for this especial reason. There can be no doubt that, in the very near future integration of the Industry will be speeded up, and the practical experience gained from existing schemes will be of tremendous value to the planners of the future.

In speaking early in the discussion on this Paper, I do not wish to mention details, but rather touch on the broad and general points made by the Authors in a Paper which must necessarily concern two major problems—namely, that of distribution and that of production.

The first points made relate to the design of a grid system for distribution, and the fact that the Authors stress the need for the capacity to be related to an ultimate final demand rather than an immediate requirement is of great importance; but of still greater importance, particularly when the economics of such a system are being considered, is the point they make on "load factor."

The cost of operating a grid, in a scheme of integration, can only be calculated in a pure sense if capital charges and running costs inherent in local gas distribution are rigorously excluded from those of the "grid proper." To keep down costs per unit volume distributed, the best load factor possible must be maintained on mains and compressors, and I am sure that the Authors are indicating a fundamental truth when they record the lengths to which they are prepared to go to exclude avoidable variable demands from the main grid system.

The question raised on wayleaves and rating are certainly interesting, but only to be expected in a country long addicted to both the passing of numerous laws and a failure to remove them from the Statute Book when the need for them has completely disappeared. I would suggest, however, that the national gas bodies and the Ministry of Fuel and Power should help the Industry in matters such as these when modern development is likely to be obstructed, and the cost of a public service needlessly and unfairly increased by outmoded legislation.

I am grateful to the Authors for conceding the fact that the size of a works is not, in itself, a measure of technical and economic efficiency—I had almost decided that I was the only person who held that opinion, but their treatment of the co-ordination of gas production is very interesting. The scheme outlined takes full advantage of available gas at existing and projected coke ovens, but it is as well to realize that this advantage will only be available in certain regions in the country where coking coals are mined, and to a limit set by the requirements of those industries requiring the particular coke produced by the oven plants. In the main, and the Authors accept and provide for it. The gas will have to be produced on the lines of accepted gas making practice, and in this connexion it is rightly stressed that the type of available coal, nature of average gas load and consequent degrees of flexibility required of the carbonizing plant, type of coke market and many other small but important points will have to be considered.

No Standard Plan

In other words, the Authors indicate, to my mind, another fundamental truth. There can be no standard plan for a district or regional grid, neither can the country be divided arbitrarily into regions for integration. Rather must each area of population be considered as a unit, its conditions and requirements analysed, and finally co-ordinated and integrated, as far as is economically worth while, with those of the neighbouring areas.

There is a point which the Authors have not touched upon, and concerning which I should much appreciate their opinion, in view of the wide experience they have had. In their assessment of ultimate demand or potential consumption in the areas in West Yorkshire not now controlled by themselves, they calculate a figure 80% to 90% above the figures for 1944, and I presume this is based to a large extent upon experience they have had and examinations they have made in the areas they do control. In the latter areas, some of their increased sales have been phenomenal, and I think I am right in stating that, in major part, they have been in the industrial field. Now my question. Has not the availability of coke oven gas supplies, without the initial need for a large outlay of capital on production plant, by itself played a major part in this development and growth since it has allowed them to explore the load, and consolidate or reject it before

finally embarking upon large capital expenditure on gas-making plant? This does not, in my opinion, make the coke oven gas worth any more either for the exploratory or permanent business, but its availability does, I would suggest, give that valuable period for trial and decision which is a boon even in these days of speed and quick decisions.

It is obvious from the case presented that, possibly after a patchy start, the West Yorkshire Grid, as outlined, was planned after enquiry and analysis, and is now being evolved rather than designed and imposed. I would suggest that if that is to be the form of future integration, then nothing but good can come of it, providing of course that no scheme is adopted which cannot, as the Authors state, reduce the average cost of gas into holder in the area under consideration. The setting up and adoption of gas grids and integration purely because they are, to some extent, novel and popular, should have no place in our future, but if it can be shown that their adoption can give, within a co-ordinated national fuel policy, even only slightly cheaper or better service to the nation, then they should be rigorously pursued.

A Master Plan

The Authors state, at the end of their Paper, that if its presentation brings home the magnitude of the work entailed in arriving at a considered programme, they will feel rewarded. I have little doubt that the Paper will have this effect on all who read and study it. In conclusion, may I suggest that this Paper would be of even more value to the Gas Industry, and to the nation as a whole, if it could be reviewed and, if necessary, revised to fit a master plan, that of a national fuel policy. The Gas Industry has been accused of failing to set its own house in order, but how is that possible, except to a limited extent, when there is no national plan into which we can fit our schemes and designs? Assessment of demands for the future must, in the absence of such a national policy, be partly conjecture. Our critics must remember that there is not even a definite policy for fuel in the millions of new homes that are to be built in the next decade, and in many areas the fuel policy adopted is dictated by local pride and prejudice instead of by true fuel values.

The Authors state they can see no signs of co-operative planning and effort between undertakings, and I would respectfully suggest that if there was a definite national fuel policy, it would be the spur required to bring this co-operative planning and effort into play, and a Paper such as they have presented would, in such circumstances, be of inestimable value.

Job for a Specialist

Mr. W. **Hubbard** (Liverpool):—At the present time, if one wishes to be popular, it is essential to speak of such things as planning, integration, regionalization, gridding, and functionalization, &c. The Authors have presented to the Industry once again further information on the now well-established West Yorkshire Grid. This distributing machine (as I prefer to call it) embodies in itself all that is now popular. They are to be congratulated on their timing and for the valuable information which they have given to the Industry. They are also fortunate young men in that, under the able direction of Col. Carr, they have had the opportunity of joining in the original conception, carrying out the planning, and putting this machine to work. I am impressed by their warning as to the detailed care which needs to be taken when considering such schemes. In my view, only by a statistical analysis of the peak loads are we likely to get anywhere with regard to costs; that is a job outside the scope of the engineer, and calls for a specialist.

In many major engineering projects it is not uncustomary to find that the engineer responsible, before completion, finds that had he been starting anew, the lines of development would have been different. If the Authors were starting again, would they follow on the published lines?

For a grid to be a success, it must of course reduce the price of gas into holder. From the information available, can they say whether this has obtained in practice, and if so, is the difference really appreciable? I very much doubt it.

The Authors appear to have made out a case for the cheapest gas to be made at the pithead. While I am unable to understand why the interest, depreciation, and dividend charges should be different in the two cases, it is obvious that the cheap gas is made owing to the absence of rail charges on the coal. But as most pits are remote from highly industrial areas, I should have expected to see some costs of gas distribution in the balance sheet. I believe I am correct in saying that it is still generally cheaper to send a therm of heat into town by rail than pump it in as gas.

In addition, for many years to come it will still be necessary to send coke into industrial areas in order to supply heat which could not possibly be supplied by an all-gas policy without involving heavy capital expenditure on plant to deal with the winter loads. I note that the Authors are favourable to a two-fuel policy.

Most undertakings have difficulties in gas distribution due to the fact that the original mains system has developed outwards from the original manufacturing stations, and the problem now is to get adequate quantities of gas into the "back" of the area without heavy expenditure.

The Authors apparently, for the purpose of control, favour connecting the grid mains to an undertaking's existing holder system, and so in any system of linking up they are not involved in any subsequent expenditure in improving the local system. One can easily imagine ample supplies of gas being available in an industrial area and yet consumers would have inadequate gas supplies or be unable to increase the amount of their gas equipment. In other words, the expenditure necessary on mains and storage, to connect the local mains system, should be of prime importance, and unless this is done, the primary object of ensuring that adequate heat will be available for all at all times will break down. In other words, because it can be shown to be cheaper to produce gas at the pit head, considerable area expenditure is necessary to ensure that this cheap gas can be used.

Finally, since the two principal reports on the Industry advocate uniform combustion characteristics, have the Authors experienced any difficulties with regard to the different types of gases being supplied into the grid?

Income Tax Obsolescence

Mr. E. M. **Edwards** (Port Talbot):—This excellent Paper clearly outlines the basic principles underlying the formulation of schemes for area gas supply. One important feature which is not referred to in the Paper, however, is that of Income Tax obsolescence. The Income Tax obsolescence allowance can be obtained by undertakings expending capital in obtaining bulk supplies. The position is more difficult where capital is expended by a gas distribution company.

As an example, the Authors mention a cost of £1,050,000 for a gas-making installation. The interest and depreciation on that installation is equivalent to 5.47d. per thousand cu.ft. If the present-day replacement cost of plant displaced is, say, £600,000, an Income Tax allowance of approximately £270,000 can be obtained. The effect of that would be to reduce the interest and depreciation charges from 5.47d. to 4.07d. per thousand cu.ft. The same principles apply if capital is spent on mains to obtain a bulk supply.

On the question of laying mains alongside railways, there are 11,933 yards included in the scheme. Can the Authors give separate costs for these? Do they recommend that mains alongside railways should be laid above ground or should be buried?

It would appear that mainlaying costs have increased by about 135% above those of 1938. Can the Authors state the percentage increases in cost of materials and wage rates respectively?

Coming to meters for bulk supplies, I would like to ask the Authors what type is recommended. Is a regular systematic testing routine followed for bulk supply meters? Further, which method of testing has been adopted?

In September, 1944, a Paper was presented to the Wales and Monmouthshire Association of Gas Engineers and Managers on "Area Gas Supply," by Messrs. Hodkinson and Taylor. It was a very valuable Paper, submitting as a basis for discussion a scheme involving large manufacturing units and high-pressure distribution over a wide area. But little further progress has been made; there are many diverse interests involved.

The South Wales and Monmouthshire area, however, lends itself to such a scheme, and the need is pressing. The industrial belt of South Wales and Monmouthshire—with 38 undertakings from Abergavenny in the east to Llanelly in the west—includes the industrial valleys running inland. In the area there are coke-ovens at collieries and at steelworks, and there are large, medium and small gas-works. Additional coke-oven plants are contemplated. A number of undertakings are taking or are about to take, a coke-oven gas supply.

But there is at present no co-ordinated scheme for the area, which is scheduled as a Development Area. There are rapidly increasing demands for gas for industrial and other purposes. During the war years we have met very heavy increases in demands for gas. All this places the undertakings in very serious difficulties. The demands for industrial gas supplies in a number of cases exceed the total annual output of the undertakings at present. So that there is a real danger of a "patchwork" development which will impede and prejudice the future development of a balanced and economic scheme of gas distribution over the whole area. There is a very urgent need for the complete and final plan of area gas supply for industrial South Wales and Monmouthshire to be prepared without delay, in order to ensure that any extensions which are to be carried out immediately will fit in with and form part of the final scheme.

I urge that our national gas bodies will deal with the Ministry of Fuel and Power and will endeavour to obtain an understanding that vital schemes such as this can be dealt with broadly now, even in the interim period prior to nationalization, rather than that there should be "patchwork" development which is not in the interests of the Industry, the public or the consumers.

The excellent Paper now presented demonstrates what can be done by men of vision and zeal. It is not enough merely to compliment the Authors; we should strive to profit from the results of their work and experience.

Mr. E. B. **Field** (Rotherham):—In the conclusion to this Paper, the Authors state: "It is hoped that it will not be thought that the advantages of bulk distribution of gas are confined to areas having surplus coke oven gas." On tracing the origin of the West Yorkshire Gas Distribution Company, however, it is evident that the whole structure of the grid, which was set up to supply the undertakings of the United Kingdom Gas Corporation, was dependent upon the

availability of large surpluses of coke oven gas in the area; had coke oven gas not been available, the total transmission cost quoted for the first stage, added to the cost into holder from a modern gas-works manufacturing plant, would have rendered the cost of the project prohibitive.

The progressive expansion of the grid remained attractive only until such time as all the surplus coke oven gas was absorbed; now, after several years of rapid development, accelerated no doubt by circumstances attributable to the war, the Company find themselves faced with the need for additional manufacturing units capable of producing gas at a price low enough to bear a present calculated transmission cost of 6.89d. per 1,000 cu.ft.

It appears from the Paper that the Authors consider this can only be achieved by a plant continuously carbonizing 800 tons of coal per day; but the fact is that the output of such a plant would, by itself, satisfy the whole present requirements of the grid, without the use of the existing coke oven supplies, which are essential to economic working.

I am prompted to ask how the Authors can justify using a manufacturing price of 20.18d. per 1,000 cu.ft. for this plant and an average gas cost of 15.52d. per 1,000 cu.ft. at this stage of development when the new plant is working considerably under its full capacity.

The need for expansion of the grid becomes apparent at this stage, and the situation in which the West Yorkshire Gas Distribution Company thus find themselves can be remedied only by expansion of their grid, as suggested in the Paper. Had this position arisen 10 years ago, there would have been every prospect of carrying the scheme to the suggested conclusion, with the exclusion of stages 9 and 16, which are economically unsound in view of the transmission charges incurred. Having regard, however, to the present position in the Industry as a whole, when most undertakings will be incurring heavy capital expenditure to meet increasing loads, and to repair the ravages of wartime working, it appears to me that the development of the proposed United Kingdom Gas Corporation Grid would be too slow to affect the larger areas of gas demand.

The Authors themselves, in the introduction to their Paper, show that they doubt the interest of the scheme to the large undertakings for these same reasons, and it becomes impossible for the grid to extend to the finality admitted in the Paper as necessary.

Some form of regionalization is clearly necessary; but surely the obvious course is to commence with integration around the larger undertakings, where new production units could be installed to meet the demands of the neighbouring smaller works, when the incidence of transmission charges would be comparatively low. For instance, integration around the undertakings at Bradford, Halifax and Huddersfield would give, using the Authors' figures, transmission costs of 1.81d., 3.68d. and 2.51d. per 1,000 cu.ft. respectively.

The Authors claim that the most economic gas making units are the coke oven and the intermittent vertical chamber oven, of capacities of 1,200 and 800 tons of coal per day respectively, though many of us will have different ideas on this point. Flexibility of plant choice should be exercised to meet the general fuel requirements of the district at all times, and many advantages could be attributed to other methods of carbonization using smaller units.

If, however, the Authors' claim in regard to plant size and type is admitted, then Leeds can already be considered large enough to operate the economic carbonizing unit suggested, and should obviously be the starting point for further grouping of the integrated areas into a regional grid.

The main fault with the Heyworth Report is the large size of the areas chosen, and in every way it would seem to be a sounder policy to commence integration in small blocks, using existing gas supplies, at the same time gradually concentrating gas making plant of economic size at the centres. I should like to express my appreciation to the Authors for their very fine Paper.

Mr. **Frederick Bell** (Liverpool):—May I, along with previous speakers, congratulate the Authors on presenting to us an exceptionally fine Paper and for putting at our disposal information which they have acquired in their unique experiences in developing a gas grid system. Technical data on distribution problems are so rarely brought to our attention in Papers of this type and I feel that with the additional specialized application in their particular case, the distribution information given has added value to us.

I notice that the Authors strongly deprecate the reinforcing of deficient district pressures in outlying portions of an undertaking's area which is taking gas from a gas grid. They agree that there are no technical difficulties, but suggest that the tappings would destroy the high load factor of the grid and would cut across the method of control. I feel, however, that this difficulty has been stressed too heavily, as it could be very easily overcome.

In the development of regional grid schemes which may become more and more prominent in the near future, it is my opinion that the principal grid mains will not run directly through the heavily-populated area of the undertakings being supplied, and therefore there will be considerable lengths of branch grid mains from the grid to the undertaking's distributing stations. In many cases, works or distributing stations are situated in congested and highly-developed areas, and therefore it will be the branch grid main which will run to the distributing stations. Surely, then, throughout the length of the branch grid main, it is possible to arrange for governors to be fitted to reinforce deficient district pressures in the outlying portions of the area.

This will, of course, necessitate additional controlling flow meters and governors situated at a point where the branch main is taken off the grid system. The control would then maintain the uniform rate of flow from the grid and so retain the high load factor of the grid generally. This would enable the local undertaking to use the high-pressure gas from the grid for distribution purposes without dissipating the energy by passing the gas into low-pressure holders. Any alteration in the rate of flow from day to day could be made from the "parent" station by remotely-controlled equipment, as, in fact, we are actually doing on an installation in Liverpool where the distributing station is some 13 miles from the control centre. Should the local branch grid main supply gas to areas where the maximum hourly demand is greater than the average intake into the undertaking from the grid, then an automatically-controlled compressor can be arranged which would come into operation and take gas out of the local storage and put it back into the branch high-pressure main.

Examination of the gas output curves of a number of undertakings show that the hourly demand for an undertaking exceeds the average demand in approximately 13 to 14 hours out of the 24, and therefore if the local branch grid were supplying all the demand, the compressors would be in use for that period of time, but they would only be dealing with a small proportion of the total output of the undertaking.

The Authors indicate that they have considered this matter with reference to three small stations, but their previous statements rather deprecate its application, which I feel is not justified. It is noticed that, in dealing with gasholder storage at outlying districts, mention is made of remote control of such stations from the "parent" station.

Remote Control Equipment

May I here put in a plea for extension in the use of remote control equipment. In my own undertaking, we have designed special types of apparatus for pressure readings, rates of gas flow, gasholder contents for both spiral and column-guided holders with alarm signals for various pressure or holder contents conditions, the information from all of which is transmitted over a single pair of telephone lines to a Central Control Room. As a result of the information so received, valves are opened and compressors or boosters started at the distant station over the same pair of telephone lines by the Central Controller.

Please do not be sceptical about the use of G.P.O. telephone lines. If we will only indicate to the Post Office that a particular line is being used for remote control work, they will give absolute priority to that line, and the Institution can be assured that in my own undertaking, since we made this point clear to the local G.P.O. Engineers, we have not had a single fault on the controlling apparatus or telephone line over the period during the last twelve months where apparatus has been controlling a small distributing station with an output of 70 millions per annum, having two gasholders, boosters, and various control valves. Such confidence have we in these controls that we have arranged for all information and controlling facilities from a 1,400 million station to be brought back to our Central Control Room.

As a further assurance in this respect, if the Electrical Industry can remotely control their switch-gear and hydro-electric stations without any local resident engineers, surely we can put our confidence in identically the same methods of control.

Having had the pleasure of visiting most of the installations in the West Yorkshire Grid Area and seeing the high standard of workmanship and finish, I consider that the work of the Authors reflects considerable credit to our Industry.

Mr. Taylor Replies

Mr. **H. B. Taylor**:—So many points of interest have been raised in this discussion that it is quite impossible to do justice to them in the time available to me. We will endeavour to reply fully in writing.

I am very appreciative of the work which Mr. Bell is putting in at Liverpool by way of remote indication and control of gas apparatus, and I quite agree with him that such development will to some extent modify the present difficulties regarding the maintenance of a constant load factor. But, with his enthusiasm for the Liverpool developments, I do suggest that he must have regard to the economic operating costs. We can very soon increase our distribution costs by mechanical and automatic aids, and the rest of it, to outstrip the amortization costs of quite considerable mains extensions. It all boils down to which is the cheaper way of giving a perfect service to the consumer. There are many technical ways of doing this. Mr. Bell is certainly developing one of them, which will be of the greatest use in grid systems in the future.

I prefer to leave Mr. Field's remarks mainly to the written reply. But I would mention that his point about integrating around the larger works is, of course, what we are suggesting in this Paper. Local grid systems, coupling up half-a-dozen or a dozen works to some central key point, some centre of gravity of the consumption of gas and coke, are quite obvious means of setting about developing an area. But I think that on examination of any such scheme we should find that there is a definite economic purpose to be served by the inter-connecting link between one such system and another. In that way you bring

about your regional grid, and the extent of the regional grid obviously depends on the extent to which you are prepared to average the costs of transmission as between the higher costs in the more remote areas and the lower costs in the more densely-populated areas. Only if the undertakings in a region can agree to average those costs, as in fact we are doing in our own grid lines, can the benefit of a uniform supply at uniform cost throughout a wide area be brought home to the public.

The Gas Industry in Switzerland: 1939-1945*

By H. ZOLLIKOFER

Secretary, Swiss Gas and Water Association

DURING the hundred years since 1843, when the first gas-works in Switzerland came into being in Berne, the Swiss Gas Industry has developed steadily. The yearly output of gas rose as follows:—

TABLE 1.—*Annual Output of Gas in Switzerland*

Year	Annual Gas Output (mill. cu.ft.)
1900	2,260
1910	5,155
1916	6,674
	(Maximum during First World War)
1920	4,590
	(Minimum after First World War)
1930	7,980
1939	9,287
1940	9,851
1941	10,381
1942	9,993
1943	9,957
1944	10,381
1945	6,850

During and after the first World War the Swiss gas-works lost the lighting load, both domestic and public. But other domestic loads have been developed considerably since 1920 by improving the quality of cooking and water-heating appliances. Some heating, industrial and special loads also have met with good success. Gas in restaurants had become quite general in the towns.

Coal Supply

Before 1939 coal for Swiss gas-works (Switzerland has no coal at all) came as to 38% from England, 23% from the Saar, 30% from the Ruhr, 4% from France, 4% from Poland, and 1% from various other countries.

During the first period of the last war, September, 1939, until May, 1940, Swiss gas-works did not import sufficient coal to meet their carbonization requirements, though it was possible then to get coal from Great Britain and the United States of America. In May, 1940, Switzerland became encircled by the Axis: the only remaining coal supply was from America. When Italy entered the war, coal transportation from the United States to Switzerland was impossible. But coal importation from Germany, though continually decreasing, continued until September, 1944. From that date until to-day coal imports have almost completely ceased. Gas-works have reached a very critical position, and do not yet see much better times ahead. They hope that 1946 will bring them more coal. The difficulties to be overcome by the Swiss gas-works are illustrated by the facts that whereas in 1939, 57,000 tons were used per month, by 1945 the amount had dropped to 12,000 tons per month.

The failure of coal supplies to Switzerland induced most of the gas-works to try to improve their yield of gas. These efforts were already begun in the period before May, 1940, but after that date, all gas-works were obliged to aim at the maximum yields possible.

On July 31, 1940, the Government decided that the calorific value of gas had to be lowered from 560 B.Th.U. per cu.ft. to 500 B.Th.U. per cu.ft. In August, 1940, a report was presented to gas-works managers concerning efficiency in the use of coal. By lowering the calorific value of gas, coal economies can be realized, but at the same time the quantity of coke available for sale will be reduced, and finally disappears when the calorific value of the gas has reached 400 B.Th.U. per cu.ft. Gas-works made serious efforts and obtained good results. In intermittent vertical chambers, for instance, with a yield of 24,711 cu.ft. per ton of coal, gas of 500 B.Th.U. per cu.ft. was produced from coal, in admixture with water gas; an average of 20,277 cu.ft. of gas (calorific value 500 B.Th.U. at 32° F. and 30 in. Hg.), per ton of coal was obtained by all gas-works. In pre-war days this yield had been about 14,000 cu.ft. per ton of gas of 560 B.Th.U. per cu.ft.

Improvements in Equipment

Improvements made between the two wars in gas-works equipment showed to full advantage. During the first World War it would not have been possible to obtain such high results. Silica refractories, high retort temperatures, distillation chambers completely charged with coal by charging machines (horizontal chambers) or by gravity (vertical chambers), steam production by waste heat, and coke dry-quenching steam boilers, &c., operated to maximum advantage.

At the end of 1940 it became probable that coal supplies would continue to be unsatisfactory. Gas sales could only be maintained at normal level by the use of other raw materials: wood, peat and lignite. In a research plant installed at Horgen gas-works, by the Swiss Gas and Water Association, wood and lignite were distilled under differing conditions. With normal distillation, gas yields of from 11,000 to 18,000 cu.ft. of wood gas of 380 B.Th.U. per cu.ft. were obtained per ton of wood.

Tests showed that the quantity and calorific value of wood gas rose simultaneously with higher temperatures in the retorts. The quality of the wood also had an influence. Numerous systematic tests were made in order to decompose steam and carbon dioxide contained in wood gas by passing the wood gas through incandescent charcoal. By this process yields of 25,000 to 32,000 cu.ft. per ton of wood could be obtained. Distillation of waste paper gave equally interesting results.

By passing wood gas through incandescent charcoal, wood tar and organic acids are cracked. By this process it was possible to obtain gas practically free from tar and organic acids. It may be of some interests to show by the following figures the influence of temperature on the yield and calorific value of the gas obtained:—

TABLE 2.—*Distillation of Wood (Composition of Gas, Calorific Value and Yield, According to Distillation Temperature)*

Kind of Wood	Fir			Beech		
Distillation Temperature (°C.) ...	700°	900°	1,100°	700°	900°	1,100°
Composition of Gas (per cent.)—						
CO_2	24.7	13.2	12.0	22.3	13.2	12.6
C_mH_n	4.0	6.1	6.1	4.0	6.5	6.3
CO	40.5	43.0	41.6	40.3	44.1	42.7
H_2	12.9	19.5	24.0	13.9	18.1	21.4
CH_4	16.9	16.9	15.6	18.0	17.4	16.6
N_2	1.2	1.3	0.7	1.5	0.7	0.4
Calorific Value (B.Th.U. per cu.ft.)	401	495	496	388	503	499
Gas Yield (Thou. cu.ft. per ton)...	7.8	14.1	19.7	7.6	16.0	20.8
Calorific Multiple (Therms per ton)	31.4	70.1	100.3	29.4	80.6	104.4
Charcoal (per cent.)	24.7	20.6	18.3	24.0	17.0	14.2

Other research investigations proved that firewood is distilled with greater advantage and produces a gas of higher calorific value when it is cut across into pieces 4 to 8 in. long.

This reasearch work was of great assistance to the gas-works in finding the best way to achieve maximum technical efficiency in wood distillation. At the moment Swiss gas-works distil about 50% of coal and 50% of wood, and produce some 22,598 cu.ft. of mixed gas per ton of fully carbonized material. Mixed gas has a calorific value between 403 and 414 B.Th.U. per cu.ft.

Before the war the gas-works had agreed to produce gas of 560 B.Th.U. per cu.ft. (decisions of meetings in 1924 and 1932). In order to economize in coal the Swiss Government, on July 31, 1940, forbade a calorific value higher than 504 B.Th.U. per cu.ft. (tolerance ± 11 B.Th.U. per cu.ft.). This calorific value was maintained until July 13, 1943, when it was lowered to 459 B.Th.U. per cu.ft. (± 11 B.Th.U. per cu.ft.). The complete failure of coal imports after September, 1944, led to a further reduction on Feb. 7, 1945, to 414 B.Th.U. per cu.ft. (± 22 B.Th.U. per cu.ft.).

By-Products

Coke is the most important by-product in Switzerland, where central heating is very general. The Swiss gas-works sold before the war 9,181 mill. cu.ft. of gas (£2.7 mill.), 360,000 tons of coke (£900,000), 30,000 tons of tar (£160,000), benzole and other by-products (£119,000). The quantity of coke available for sale is reduced in proportion to the lowering of the calorific value of the gas. At the moment, therefore, no coke at all can be sold.

Tar was a very important by-product during the war. The Government handled the entire output.

Benzole plants existed before the war in some important gas-works, but the number increased during the war, until now one-third of all Swiss gas-works are equipped for benzole recovery; a Swiss process is used in two of these plants.

Sulphur.—The rapid reduction of sulphur stocks in Switzerland awakened great interest in the sulphur contained in spent oxide.

* From "The Gas Industry Overseas. 1939-45." Communication No. 299 of the Institution of Gas Engineers.

sulphuric acid and carbon disulphide were produced in special plants.

Ammonia is no longer interesting commercially, and at the end of the war gas-works had stopped treating ammoniacal liquor.

Charcoal offered no interesting commercial outlets for gas-works. While coke, in pre-war days, had been produced and sold directly to their customers by the gas-works, they were no longer allowed to sell charcoal directly. Thus the price paid to gas-works for charcoal was less than one-half of the price paid by the consumer.

Gas and By-Product Sales

In spring, 1940, and again in 1941, all gas-works were allowed to raise the price of gas by 0.009d. per cu.ft., *i.e.*, 0.018d. per cu.ft. in all. (Three gas-works have continued up to now to charge the pre-war gas price). Electrical competition makes it impossible to raise gas prices in proportion to costs. Gas produced from wood is much more costly than coal gas. Most gas-works have, therefore, incurred financial losses since February, 1945.

In March, 1942, the Government thought rationing of gas to be essential. A Federal Bill prescribed rations based upon, first, the consumption per member of a household; second, the number of members of a household; and, third, the pre-war consumption of the consumer. In February, 1945, this system was replaced by rationing based exclusively on consumption per person. This system caused an enormous reduction in gas sales which may be estimated at between 30 and 40%.

Simultaneously with the failure of coal, the quantity of coke available for sale was reduced. Since February, 1945, gas-works no longer produced quite sufficient coke for heating their retorts.

Tar and benzole sales were, until September, 1944, of the greatest interest. When coal imports stopped, tar and benzole sales were reduced considerably.

Sales by gas-works during 1945 were as follows:—Gas, 6,356 mill. cu.ft. (£2,476,190); coke, nil; tar, 9,000 tons (£90,476); benzole and other by-products, 1,500 tons (£71,428).

Lack of coke, higher wages, higher prices for coal, wood, and all raw materials have transformed the former revenues of the gas-works into losses. The gas-works under municipal ownership producing about 90% of the total output, can arrange with local authorities to cover these losses. But companies have great difficulties, and are to be subsidized by the Government. There is hope, however, that better conditions will return in the not-too-distant future.

The Preparation of Coke

Discussion on the Paper by P. C. Gardiner, F.R.I.C., M.I.Chem.E., Chief Chemist, Tottenham and District Gas Company, at the Annual Meeting of the Institution of Gas Engineers. The Paper was published in abstract in the "Journal" of Aug. 21 (page 312) and Aug. 28 (page 359).

COLONEL H. C. SMITH (Tottenham and District Gas Company):—I am very glad of the opportunity of saying a few words on this Paper as I know the very great interest and attention that Mr. Gardiner has paid to the preparation of coke for the last 26 years. I think the Paper is a most valuable one. We keep on talking about the coke market but I suppose to-day Mr. Gardiner is talking to the converted. I am only too sorry that many of the people whom we ought really to be talking to are not here. I, as I often find to be the case, do not agree entirely with what Mr. Gardiner says. We have many arguments and discussions together, but of course it is only out of such arguments and discussions one gradually gets anywhere. Mr. Gardiner says, or suggests, that it would be a quicker process to provide the public with coke that can be burned in any open grate than it would be to provide suitable grates for burning the coke that we make. But I feel we have to look farther than that. We ought not to say that the old-fashioned coal grate is the right grate to burn a modern fuel such as coke.

Coke is a specially prepared fuel and it requires, at present, special appliances in which to burn it. We must not forget that we started to use gas fires which consisted of asbestos rings in the old coal grate. We put a burner underneath and lit it and said we had a gas fire. But the gas fire has developed far beyond that stage, and I think we have to look on coke as a fuel that requires a special appliance in which to burn it. Before the war these special appliances were available and were being rapidly installed in very large numbers. However, that does not mean that we should not, at the same time, do our best to make coke that will burn in an ordinary domestic coal grate, but I do not agree that to do that would be a quicker process. I think the two processes will have to go along side by side. In new premises I see no reason at all why the new appliances should not be installed which will burn a far greater variety of cokes than the coal grate will. At the same time we must try and prepare a coke that will burn properly in the old type of coal grate.

Wishful Thinking

I am glad that Mr. Gardiner stresses the importance of clean coal and he refers to some tests that were made at Tottenham many years ago in conjunction with Dr. Lessing. In those tests we carbonized South Yorkshire slack which had been cleaned down to the inherent ash, but I am afraid it was wishful thinking when Mr. Gardiner said: "The dust is saleable as powdered fuel, but difficulty is met with in disposing of the refuse, which naturally has a very high ash content. However, accepting this fraction as valueless, all the costs of the cleaning were covered by the extra value of the cleaned coal for gas-works use." The balance sheet which we drew up at the time of the tests does not quite substantiate Mr. Gardiner's statement, but what the tests did prove was that the coke which was made from this cleaned coal was far superior to any coke that any of us had ever had experience with. The item in the balance sheet which killed the scheme was the fact that we had to carry that ash from the colliery to the works. I am glad that the Gas Research Board are proposing, at as early a date as possible, to conduct a full-scale experiment over a period of 12 months on a works of sufficient size in order to try and ascertain what the economics are of carbonizing coal cleaned to this degree of cleanliness.

I am perfectly sure that such an experiment will pay a very large dividend. We do want to know how much we can afford to pay the collieries for cleaning coal to this degree. Perhaps now that the coal industry is going to be nationalized they may devote their attention to preparing coals in such a way as to make them acceptable in various markets. Despite all that is said, we still have to put up with a state of affairs in which coal is raised from the ground, roughly screened, and sent to us whether it is suitable for our purpose or whether it is not. After all, in every other kind of industry the seller has to prepare his products for sale in accordance with the consumer's requirements. Flour is blended and tea is blended, so why should not coal be properly prepared to make it suitable for the user's requirements. We as the users have to make gas to specific standards. No excuse would be accepted from us if we said we were very sorry that the gas was not as good as it should be because the coal quality was inferior. I hope the time is coming when that side of coal production will be tackled seriously. It would be nice for a change to see some really practical efforts being applied to the coal industry instead of political ones.

A High Aim

Mr. **F. B. Richards** (Chairman, Woodall-Duckham Companies):—I very much appreciate the opportunity of saying a word on this subject of coke. Our thanks are due to the Author not so much for producing new facts but for having marshalled so many facts in such a very concise form and I think it is fair to say that there is no one better placed than the Author to do that job. He has an undertaking of sufficient size to have a diversity both of type of plant and geographically, so that they can draw upon different sources of supply of coal. Consequently, his contribution possesses, to my mind, a very special value, and I am glad he has emphasized, as he has done, the importance of the coal, and the rank of the coal. That, I think, has been insufficiently recognized in the past and the old proverb that you cannot make a silk purse out of a sow's ear is exemplified in the case of trying to make coke out of a bad or unsuitable coal.

The Author takes as his aim the production of a coke which is equally suitable for all purposes. There I think he is perhaps aiming a little high. However that may be, fortunately or unfortunately, most gas undertakings have little or no choice in their source of coal supply. Geographical and commercial considerations usually fix the type of coal they have to take and their degree of latitude is really confined to seeing how they should treat the coal when they get it and how they should treat the coke after it is made. Here again, I think one is wholly with the Author in that next after the source of coal comes the method of treatment of it. Moreover, nothing you can do to the coke after it is made will produce qualities that you might get from a totally different coal. It is perhaps fair to say, however, that gas undertakings which can aim at producing more than one sort of coke are few. The average undertaking, as the Author suggests, has to aim at producing something which will be acceptable for all purposes. Undoubtedly, the first point in that connexion for the domestic user is ignitability, and almost equally important is cleanliness.

On the question of cleanliness, the form in which the ash is present is vitally important, and those of us who have had the job of stoking the domestic boiler during the war have had the unfortunate experience that each night the fire is liable to go out because the bats in the coke have occupied nearly half the space that should be devoted to fuel. If the ash had been in the finely disseminated form in which the metallurgical coke producer generally converts it by crushing his coal, then no trouble would be experienced even with a very considerable ash content. Therefore, I think the question of the form of the ash, which the Author fully recognizes, is one of great importance, and I agree with Colonel Smith that the right place to remove that ash is the colliery. I see little hope for success in attempting to do the

cleaning at the gas-works, and I am a little sceptical as to the possibility of a common centre for cleaning a number of coals because different coals need different treatment in cleaning.

The question of absorbing at least a part of the dust produced from the coke in the screening and cutting operations is one which the Author touches on and it is one which, from time to time, has interested a good many people, but in most gas-works there are no facilities for regular mixing of the dust with the coal and because of that it is not practicable, even if a coal has a sufficient surplus of binding power, to use the dust successfully because it does require special equipment and a special lay-out the cost of which can only be faced in connexion with large installations.

Removing an Abomination

Mr. **T. F. E. Rhead** (Birmingham):—Mr. Gardiner has done a very great service in connexion with coke for many years and gave some very valuable evidence to the small Panel set up during Sir Frederick West's Presidency. My contribution is more in the nature of a question. I look upon coke screening as a dirty process and an abominable job and I would like to make a suggestion which to the orthodox engineer may sound a little foolish. I have something of a hunch that coke screening can be carried out in a totally enclosed, fully automatic screening plant to get rid of the dust, with air locks for the ingress and egress of the coke. There would be no need to suck the dust away from such a plant—it would just work in its own atmosphere, a technique used in the preparation of certain chemicals. Such a plant would cut out the expensive and elaborate apparatus for cleaning the air in the normal type of suction plant. If that could be done one of the abominations of gas-works would be removed.

Dr. **G. E. Foxwell**:—Mr. Gardiner is to be congratulated on bringing before us a provocative Paper. He has raised the issue of what it to be our coke policy, a very important question for the Gas Industry, which is not a one-fuel Industry as so many people think, but a two-fuel Industry. I suggest that the Fuel and Power Advisory Council's Report has given the answer, and I propose to read two short extracts from that Report. On page 13, it is stated: "There is general agreement that the winter space and water heating load is likely, so far ahead as we can see, to continue to be taken by solid fuel. In our view this is in the interest both of the householder and of the nation." Again, on page 15 of the Report, we read: "It is of fundamental importance entirely to replace bituminous coal for use in the individual small house by smokeless fuels. We recommend that it should be the policy of the Government to replace bituminous coal in all single house appliances by smokeless solid fuel as rapidly as adequate supplies can be provided at a reasonable price." The duty of the Gas Industry, I maintain, is to provide this solid fuel, which will be wanted in enormous quantities. I think there is no doubt where our future lies. But how does Mr. Gardiner meet this challenge? He meets it by concentrating on the production of coke suitable for the existing open fire, and there I cross swords with him. I do not believe we can produce a suitable fuel by high temperature carbonization. Only recently I was sent a bag of coke made from a low rank coal of the type suggested by Mr. Gardiner. I sent it to friends who had open coal fires and with one accord they said it would not do.

"Operation Snowball"

I suggest we must have satisfied consumers who will, to borrow what might have been a wartime phrase, sell it to one another by "Operation Snowball." Many coal grates will not even burn coal satisfactorily, then how will they burn coke? Many more of them will not burn coke and coke will therefore get a bad name. I wonder if Mr. Gardiner has made this fuel and tried it on the market. I feel, somehow, that he has not done so; I have had a great many years' experience trying to do this by high temperature carbonization when I was in Sheffield and we did not get very far. There are two solutions to this question, but Mr. Gardiner deals only with one of them, and that not entirely satisfactory. The first is to use a low ranking coal, but as such coals have a low gas yield, economics come in here, a subject which Mr. Gardiner has not touched upon. I feel he ought to have done so. I have repeatedly asked practical people to deal with those economic questions in public, but I have not been able to persuade any gas engineer to do so. There is another method which is technically satisfactory, and that is to subject the coal to low temperature carbonization; here again, however, we want a statement on the economics of the process applied to the Gas Industry and I hope the President will get the South Metropolitan Gas Company to give us such a statement.

It is suggested by Mr. Gardiner that alkali activation is the method to be adopted, but I do not agree. Many of those who have tried it in the coke oven industry will have nothing to do with it. They hold that not only does it add ash to the coke but it causes the coke to become covered with a layer of adherent ash which spoils its burning properties after an hour or so. I think the Gas Research Board should do some work on this subject.

I want to ask Mr. Gardiner, also, whether we want to perpetuate the open grate as now established? Here is another extract from the Fuel and Power Advisory Council's Report (page 5): "Few applications of fuel are so wasteful of heat and so inadequate in result, as room heating in this country by the open coal fire," and this is the appliance that Mr. Gardiner wants us to perpetuate! Has our Fuel Efficiency Campaign indeed been a casting of pearls?

I want, also, the Industry to face the sale of suitable appliances. I do not think there is the difficulty Mr. Gardiner seems to think. I received quotations—admittedly some little time ago—for some of these new appliances which gave figures of the order of £3 to £5 fixed, for modern appliances. The coal industry hoped to sell the Hales fire in large quantities, but the cost is about four times the figures I have quoted. If the Gas Industry can get gas fires fixed by hire purchase or in other ways, then they might also get coke fires fixed in the same way—if they want to. The question is "Do they want to?" I feel that the right policy is to get the right conditions through the right fuel burning in the right appliances and get every consumer satisfied. I believe that the Ministry of Fuel and Power is now studying how far the Fuel and Power Advisory Council's Report can be put into effect. That is a pointer to what we can do to our future policy.

One final point, and that is with regard to low ash coal. I think Mr. Gardiner and all of us must consider very carefully how we are going to get such coal. Here is one example of producing not exactly a low ash coal but a lower ash coal. A colliery washed coal containing 9% of ash and reduced it to 5% and in doing so they increased the calorific value of the coal by 6%; but they removed 33% of the washed coal in the form of high-ash coal containing 17% of ash. I mention this not to suggest that that would be the general position, because there are many coals to which such figures do not apply, but to show that collaboration is necessary between the members of the triumvirate, the fuel and power industries, to which Mr. Shinwell referred at the luncheon in order to find out which coals should be washed and consequently to ensure that the middle product, where it is produced, can be sold so that we do not waste our dwindling coal resources.

Mr. **W. Morland Fox** (Director, W. J. Jenkins & Co., Ltd.):—Previous speakers have dealt with one of the issues I want to present to you, Colonel Smith and Dr. Foxwell having queried the production of a specialized coke for any type of appliance. My other point is that while the ideal coke suggested by Mr. Gardiner with 4% moisture and 4% ash is excellent, the figure of 21 lb. per cu.ft. bulk density seems too low, particularly in view of the remark with regard to too rapid burning of unsuitable cokes mainly produced from low rank coals. Table 2 shows the difference in the coke from three types of coal, viz., Durham, South Lancashire, and Derbyshire, when carbonized in the two types of plant, *i.e.*, intermittent vertical retorts and continuous vertical retorts, and the Author states very definitely that coke produced from low rank coals in continuous verticals has a great advantage. This is a somewhat surprising statement to me—and I think also to many other people in the Industry. I have read through a large number of Papers during the past few years in which very eminent members of the Institution have suggested very strongly the use of static carbonizing plant for dealing with low ranking coals. Economics comes into this, and I do not believe that anybody will disagree with my statement that the breeze production from low rank coals in continuous verticals is extremely high. Speakers have indicated that it is difficult to dispose of this and it would be interesting if Mr. Gardiner would give us comparative figures of the breeze content of low rank coals when carbonized in the two types of plant which he mentions.

There is one other point, and that is with regard to hot coke handling and quenching. I have had the privilege and pleasure of seeing the installation mentioned by Mr. Gardiner in his Paper and I was highly impressed with the efficiency of working of the quenching and screening plant, and also with the quality of coke produced. I would, however, offer a word of caution. In that plant I think Mr. Gardiner was carbonizing Durham coal, but with low ranking coals you get a much more friable coke and when you use the Le Feuvre conveyor it breaks up very rapidly when it gets into the water trough and absorbs an enormous amount of water in comparison with coke from Durham coal. I believe that some of the old-fashioned methods of handling hot coke by the scraper chain are much more suitable for cokes from low grade coals.

Mr. **Cecil H. Bamber** (Rochdale):—I am a supporter of Mr. Gardiner so far as the preparation of coke for general use is concerned. I am not seeking to perpetuate the old-fashioned grate but many millions of modern grates have been installed during the past 10 or 15 years in which coke can be burned, if it is the right kind of coke, and no one with any imagination is expecting these grates to be removed within quite a number of years. The work done in design of special grates for coke burning has certainly been of great value, and will continue to be so far as installations in new houses are concerned, but anyone who has had the practical difficulty of installing any of these modern grates in existing houses, with all shapes and sizes of fireplaces, and with householders reluctant to pay for the alterations required to the grate, will realise the necessity for preparing a coke suitable for burning on existing modern coal grates. The British Coal Utilization Research Association is seeking to perpetuate that type of grate. Their most modern designs do not differ materially from the grate that has been installed as a living-room grate for quite a few years now.

The questions on which I am going to differ from Mr. Gardiner are, I think, two-fold. He says it is necessary to produce a light coke—I hope I have understood him aright in his Paper—from vertical retorts in order to get a free burning domestic coke, and secondly, he says it is necessary to use for that purpose a low rank coal. Perhaps I am connecting the two rather more loosely than he has done in his Paper, but he makes two essential points, viz., bulk density, and origin

of the coal. On the question of bulk density, it is true that usually very light cokes have a high reactivity and are free burning, but it is not always true. I have seen very unreactive cokes from light types of coke of that character. The big disadvantage of that type of fuel is the small amount of carbon one puts on the fire at one time. Many of us, as has been mentioned, have had to stoke our own grates during the war and it is a fact that one can be putting on a shovel-full of coke every hour if you use very light vertical retort coke. I should say that a bulk density of about 70 cu.ft. per ton would be more suitable than the value of approximately 100 quoted by Mr. Gardiner.

As regards the second point about the origin of the coal, I do not agree that reactive cokes can only be made from low rank coal. I had occasion to work on some experiments a few years ago—which unfortunately have been interrupted in the same way that many of our activities were during the war—on the production of coke, and the ash, of course, from relatively high rank Lancashire and Yorkshire coals, and we succeeded in making highly reactive cokes. The principal feature—it is not generally known—was the circulation of hot water-gas through the vertical retorts. Exactly how the mechanism of that reaction takes place, I am not prepared to discuss at this stage. If we had a little more time I might have been prepared to discuss it in some detail, but we successfully produced a very free burning coke from relatively high rank coal. I think the position is somehwat parallel to what we have been doing during the war in the production of activated carbon, which attempts it has been thought should never be made on coals of the anthracite type, but we have used relatively high rank coals for that purpose. I do not know whether it has actually been established that one can only produce reactive cokes from low rank coals, but I suggest it is possible to produce reactive cokes from high rank coals, and that possibly merits considerably more investigation than we have given to it so far. I thank Mr. Gardiner for his Paper. I am sorry if I differ from him on these two points, but his Paper puts in a very comprehensive form literally all the problems that we know are associated with the manufacture of coke in gas-works.

Mr. **Geo. E. Currier** (Bradford):—At no time in the history of the Gas Industry has there been so great an opportunity for the development of the coke market than the present. There is no doubt that Government Departments are becoming more impressed with the need for smoke abatement. The Domestic Fuel Policy Report by the Fuel and Power Advisory Council of the Ministry of Fuel and Power makes recommendations which, if implemented, will bring about the abolition of domestic smoke in the next 20 years. This Report recommends the use eventually of only smokeless fuels for domestic purposes. At the present time, due to the serious domestic coal shortage, great numbers of the population are, of necessity, having to use coke for the first time, and it is certain that many will, as a result of their present experience, desire to continue its use. There is no doubt that gradually the people of this country are becoming more smokeless fuel minded, and with the general desire for one solid fuel fire in the home, it is reasonable to expect that in future there will be a greatly increased demand for it.

It is with particular pleasure, therefore, that I welcome the submission of this Paper. It is conceivable that the demand will become so great that consideration will have to be given to the production of some coke as a main product of the Gas Industry. Clean coal is a fundamental governing the production of coke satisfactory to the consumer. The following float and sink test results of four types of coal indicate the very considerable improvements in gas yield and coke quality which could have been obtained by proper treatment at the colliery.

	Total ash %	Ash in shale free coal %	Distribution of ash: Shale %	Distribution of ash: Ash in shale %
Coal A	13.2	6.6	16.5	40
„ B	10.8	2.9	13.7	58
„ C	10.1	3.3	10.1	60
„ D	5.9	1.8	7.0	70

These figures amply confirm those given by the Author and indicate that the Gas Industry should be supplied with coal low in ash content and suitable for each particular carbonizing plant. The grading of coke perhaps ranks equal in importance with ash content, since the reactivity of coke in a given appliance is dependent upon satisfactory sizing. In this connexion and to obtain uniformity of marketing throughout the country, the standard size nomenclature quoted by the Author and recommended by the Institution of Gas Engineers should be adopted throughout.

No mention has been made of the effect of screen loading upon the size range of any particular grade produced, but uniformity of grade can only be obtained by regular screen loading. The following figures show the effect of variable loading on two types of screen considered from point of view of No. 2 coke:

	Screen A Loading: Normal %	Screen A Loading: High %	Screen B Loading: Normal %	Screen B Loading: High %
0 in.- ¾ in.	2	Nil	4	2
¾ in.-1 in.	40	24	26	7
1 in.-1½ in.	45	52	50	35
1½ in.-2 in.	13	24	20	56

Our experience concerning the distribution of ash and moisture in the various grades is, in general, similar to that of the Author, viz.:

Grading	Ash %	Water %
0 in.- ¼ in.	11.1	14.5
¼ in.- ½ in.	15.6	15.0
½ in.- ¾ in.	15.7	13.0
¾ in.- ½ in.	12.2	13.0
½ in.- ¾ in.	10.4	12.0
¾ in.-1 in.	8.1	6.5
1 in.-1½ in.	8.1	7.4
1½ in.-2 in.		6.6
Over 2 in.		6.4

The scalping of all coke below 1¾ in. and its use for boiler and producer fuel after screening is not possible in the case of continuous verticals using West and South Yorkshire coals, the coke from these being generally friable and the size range of the original coke being:

	%	
0 in.- ¼ in.	22	} i.e., approx. 70% below 1¾ in.
¼ in.-1 in.	11	
1 in.-1¾ in.	37	

Reactive Coke

I am in entire agreement that every effort should be made to produce economically a more reactive coke which will enable it to be burnt more easily in special grates and satisfactory in all existing types. Whether this can be done by activation, by adjustment of part of the carbonizing plant or by segregation of coke from clean coals, carbonized in a separate section of the plant as done in Bradford before the war, are subjects requiring further and local consideration.

In addition to every care being taken in the preparation of coke and its marketing free from dust, there is a real need for the implementing of the recommendation of the National Federation of Gas Coke Associations for the provision of display centres where potential consumers could see the latest coke appliances and their standard of performance. Finally, it is opportune to pay tribute to the National Technical Committee of the National Federation of Gas Coke Assotions in the excellent work which they have done, and are still doing, in the development and improvement of all coke burning appliances, and also with regard to the production and preparation of coke suitable for all purposes.

Mr. **L. G. Townsend** (Liverpool):—The Author is to be congratulated on a survey which should go a long way towards once again focusing attention on the production of easily ignitable and free burning coke. There is no doubt that there is, at the present time, with the continued shortage of solid fuel of all kinds, a tendency to allow the question of coke quality to fall into the background. For some time past the domestic consumer of solid fuel has been obliged to accept almost any material available and complaints regarding its quality are not readily made. It is not to be expected that this state of affairs will continue.

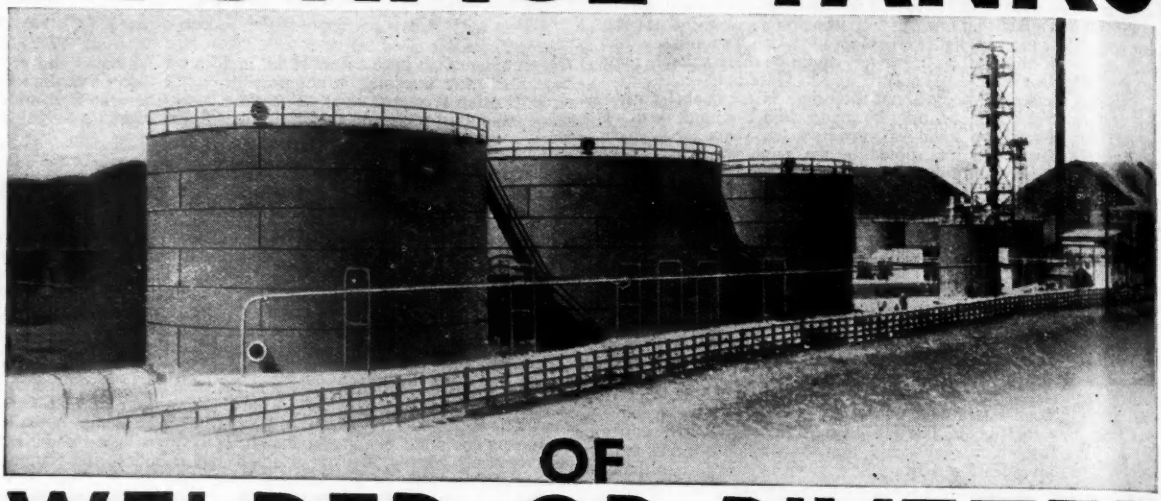
I think it may be taken for granted that, for some time to come, the Gas Industry will continue to have for disposal some 10 cwt. of coke per ton of coal carbonized and the time will again come when it will be necessary for us to ensure that this coke will find a ready market. The Author's point that all coke should burn in an open fire of any type is, at this stage, a counsel of perfection. Nevertheless, this is the object which should always be before our minds.

There is no doubt that in the production of free burning coke the continuous vertical retort will always be to the forefront. This does not mean, however, that it should be regarded as a *sine qua non* for this purpose. The type of carbonizing plant in use cannot normally be regarded as a variable factor in any properly designed works, even of the largest size. It is only where renewal or replacement of plant is considered that there is any choice possible, and even here the quality of the coke is only one of several aspects, though nevertheless an important one.

For this reason, therefore, I should like to stress the importance of the influence of the carbonizing conditions on the nature of the coke. With any particular class of coal and carbonizing plant very considerable variations in the nature of the coke are possible. This is particularly the case with types of carbonizing plant which normally produce a less reactive coke—intermittent vertical chambers and horizontals. It is essential that steps be taken to ensure that, under no circumstances, are charges over-carbonized. Coke should never be allowed to remain in a retort when gas evolution has practically ceased, without the admission of steam. This is essential not only from the point of view of coke production, but also from that of gas making and refractory preservation.

The object in stressing these points is that the whole question of alkali activation is very much undecided. Good results have been obtained at Liverpool with cokes of the more reactive type, but knowledge of the effect on inert cokes is far from complete. Until it has been established that activation is the solution of the problem, every effort should be made to improve the coke by means already at our disposal. Investigations made so far, indicate that alkali activation *alone* will not convert an inert coke—say from Durham coal in I.V.C. with a C.A.B. greater than 0.060 cu.ft. per min.—into a full burning coke of the type we are considering. Such a type would have a C.A.B. of 0.045 cu.ft. per min. or less. For the production of good coke of this type I consider that the first essential is rigid control of carbonizing conditions, such conditions being decided on by previous experiment. Secondly the application of activation where this may be usefully employed. Thirdly, where the first two items have proved insufficient, alteration in the type of coal carbonized. This third consideration will generally be in opposition to gas making results

STORAGE TANKS



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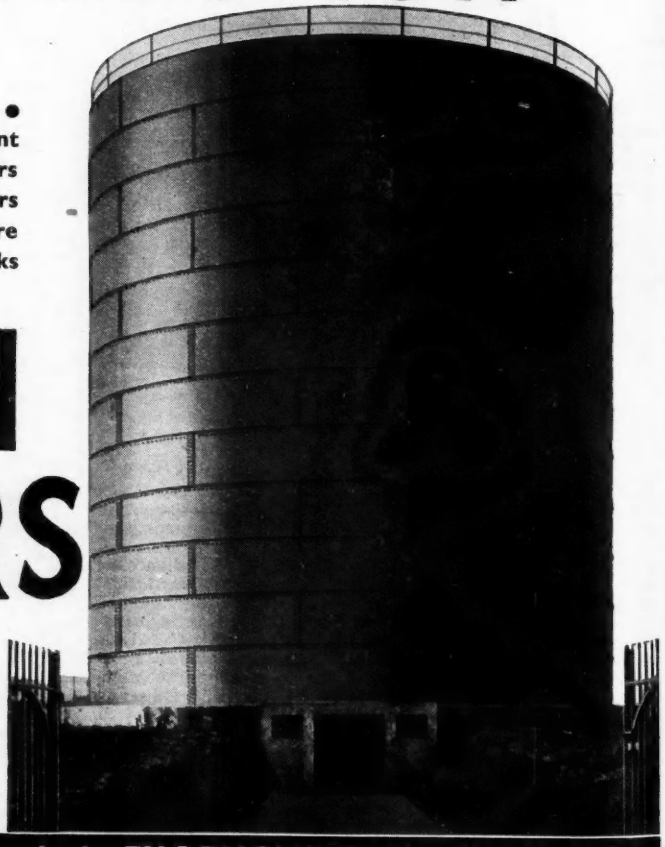

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and initial cost and has therefore been relegated to this position. It is assumed that the requisite grading is carried out.

I should like, at this point, to say a word on the subject of coal cleaning. While it is undoubtedly true that thoroughly cleaned coal with a low ash and moisture content is highly desirable, it is extremely doubtful whether this will ever be forthcoming from the collieries. Such cleaned coal would raise a problem in the disposal of the refuse which contains appreciable amounts of combustible material. The days when such material could be discarded are over and the collieries will not lightly assume this burden. It is possible that such material could be utilized on specially designed steam raising plant, but the whole question is very complex, even were the cleaning to be carried out on the larger gas-works.

The problem has similarities to the breeze disposal question. There is an increasing tendency for steam raising to be confined to waste-heat boilers on many works, other than base load power being supplied by purchased electricity. This means that there will always be a surplus of breeze for disposal, which will not always find a ready market. Moreover, continuous vertical retorts which provide most water heat steam also produce comparatively large amounts of breeze. The logical solution of the problem on the larger works would seem to be to generate electricity from steam raised in the C.G. boilers designed to burn breeze. It should be pointed out, however, that coal-breeze blending may also provide a solution. It is possible with a well designed blending plant to produce full burning coke of good abradability and at the same time keep breeze to the minimum. In fact, with close control of a well designed installation it is possible to obtain good gas-making results and at the same time call for imported breeze.

At this stage, a short resumé of the present position at Liverpool is of interest. It has always been the policy to manufacture a large proportion of reactive coke from low rank coals by carbonization in continuous vertical retorts, under controlled carbonizing conditions. This coke has always had a ready market, will burn in any grate, and is reasonably strong. The type of coal carbonized is confined to one or at most two definite sources. The ash and moisture content of the coke are each of the order of 5% or less and the dry bulk density ranges between 20 and 24 lb. per cu.ft. This coke will ignite readily on 4 cu.ft. of gas and the C.A.B. though somewhat variable averages 0.040 cu.ft. per min. or rather less. Debreezing is carried out, but for the open fire close grading is found unnecessary. There is no evidence that the gas making results suffer materially as a result of manufacturing this coke, at the present time. It must be remembered, however, that the coal carbonized, even with its high inherent moisture content, contains less inert material than most other coals supplied to-day. For this reason their inferiority from the gas making point of view tends to diminish. A further point in favour of this production of reactive coke is that the breeze produced appears to be rather less than average. This can, I think, be attributed to the uniformity of the coal. In this connexion, it should be borne in mind that when special coals are segregated for this purpose, additional handling charges—depending on local circumstances—may be incurred.

There is no doubt that this method of smokeless, reactive fuel production at Liverpool is successful, but it may not be a general solution to the problem depending, as it does, on the availability of coal of appropriate quality. For this reason alone the alkali activation process calls for further investigation. In conclusion I should like to thank the Author for a Paper which is as valuable in its implications as in its substance.

Written Contributions

Mr. **Harold H. Thomas** (Liverpool Gas Company) wrote:—I wish to congratulate Mr. Gardiner upon the general theme of his Paper. His appeal is for improvement in the quality of coke which will ensure it forming an acceptable fuel for the domestic consumer using existing appliances. This policy is entirely consistent with the Report of the Fuel and Power Advisory Council on Domestic Fuel Policy. The importance of developing the use of smokeless fuels was emphasized in this Report, and it can be assumed that any modifications which the Industry is able to make to this end presumably will be approved and encouraged. The economy of the dual smokeless fuel service (gas and coke) from the points of view of both the domestic consumer and of the nation has recently been demonstrated, notably in the very elegant paper by Andrew, Dunning, and Holliday and in the Egerton Report; the Industry should therefore study and endeavour to develop the production of a reactive coke.

The relatively low gas making quality of the most suitable coals is mentioned. This point will be accepted but the further factor which affects the comparison is the ease with which such coals can be carbonized—the output from a particular plant could almost certainly be increased materially whilst maintaining less severe carbonizing condition, thereby reducing both the capital and repair and maintenance costs per therm.

Once again there arises also the dream of clean coal. In some cases current increases in gas demand might possibly be met with existing plant using coal of low ash content. Is it possible that the modification of the coal industry which is now taking place may include especial consideration of this matter with a high priority? The value of clean coal to the Industry will require to be assessed. It must not be concluded that a still higher price is warranted without study of all the implications. It may be that the price of the inferior coals should be reduced while maintaining that of the coal of a specified high quality at the present level. The factors which determine the ultimate quality of the coke are summarized and discussed by the Author, and the Paper will enable desirable procedure to be defined in a particular case.

Low bulk density is used as a measure of suitability for open fires. This property is not, however, an entirely reliable indication of reactivity and I would suggest that the C.A.B. or volatile therm tests separately or together should be used in addition. The final criterion is, of course, the open fire test. Low bulk density is, in fact, a disadvantage, and experiment should be directed towards producing a dense coke while retaining the combustible property. Improvement in this respect may result from the carbonization of a consolidated charge of small coal, and information which may be available on this point would be valuable. The process would almost surely have to use a static charge. Alternatively, the reactivity of the more dense fuel may be increased by activation with alkali.

The Author refers to the Liverpool experiments which were reported to the Institution in 1940. He enquires whether the coal used in the activation experiments may not have produced a satisfactory open-grate fuel without activation. This depends upon the standard which is set. The object of the investigation was to produce a fuel equivalent to "Dryco," and this was not achieved with carbonizing conditions adjusted on a gas production basis. The coke so produced was a normal vertical retort coke and would have given reasonably satisfactory performance in a coke grate. It was not, however, a satisfactory fuel for normal well grates, and it was brought into this category by activation.

The use of alkali subsequent to carbonization is receiving further attention from Mr. Askey. It would also be interesting to hear from Mr. Rhead the results of experiments which he has been able to make on the plant at Birmingham using domestic sizes of coke.

Mr. Gardiner's conclusions summarize the facts, and modification of procedure which is found to be practicable with these points in mind will certainly contribute materially to the prosperity and health of the consumer, the Industry, and the nation.

Two Adverse Factors

Mr. **S. K. Hawthorn** (Birmingham) wrote:—There are two adverse factors in the preparation of a satisfactory coke: (*a*) High ash content in coke for all purposes, and (*b*) poor reactivity in coke for open fires. The complete answer to high ash would be the removal of ash from the coal at the collieries. Very great benefits would result if this could be done, and the Author's figures of the greatly increased yield of large coke, and the reduction in breeze in coke from clean coal, are most impressive. It is, however, improbable that a general cleaning of coal at collieries will take place for a long time, and in the meantime the Gas Industry can take the course of cleaning the coke. The smaller sizes, *i.e.*, below 1¼ in., contain more ash than the larger material and for many years coke, from ⅜ in. to 1¼ in. has been cleaned with complete success in Birmingham, by washing and by dry cleaning processes.

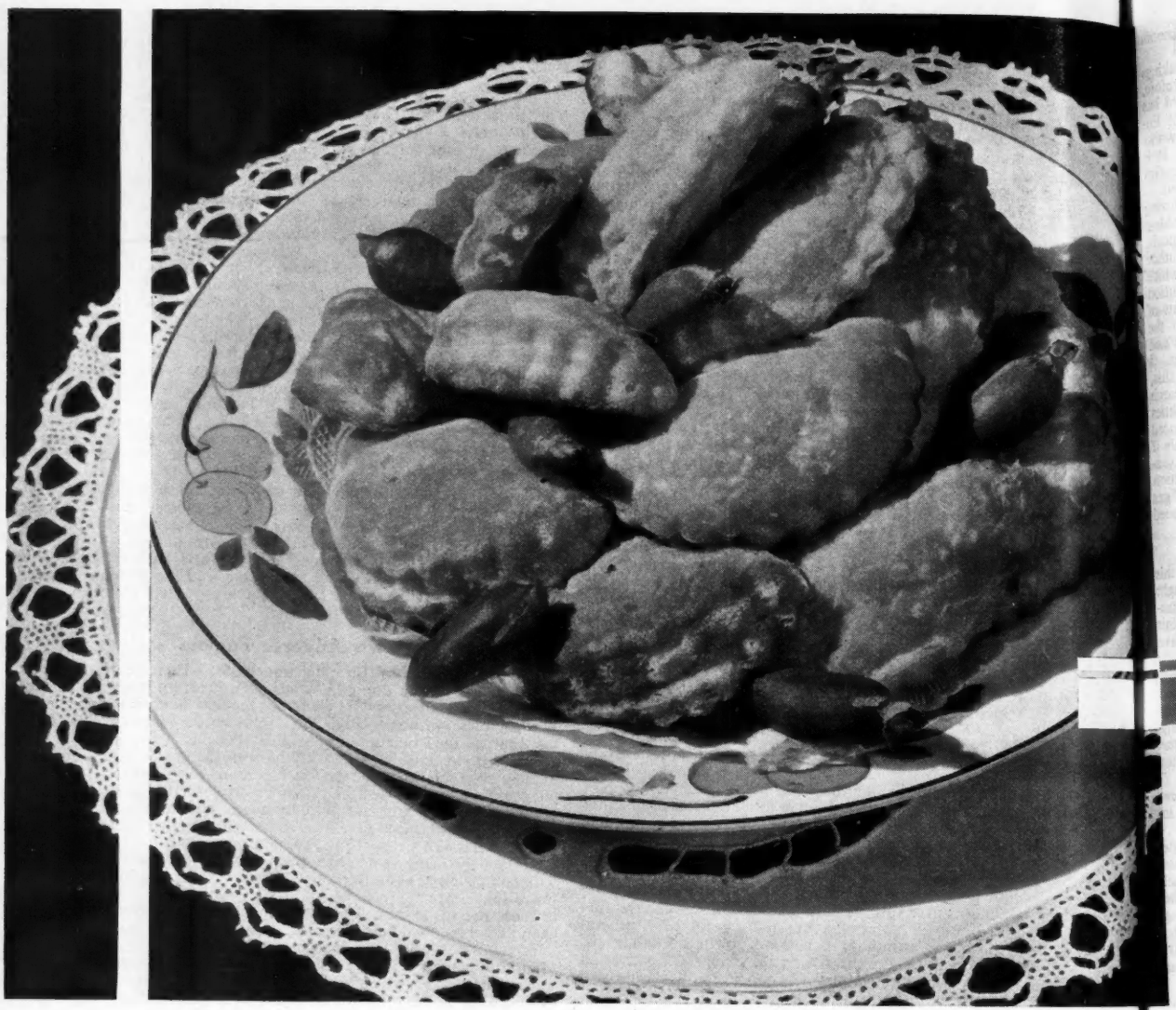
With regard to reactivity, continuous verticals give better coke than all forms of static carbonization from the same coal, but even in continuous verticals the influence of throughput is very considerable. High throughputs leaving a volatile matter content in the coke of not more than 2 or 3% give much higher reactivity than low throughputs. Over-baking of the coke results in low reactivity. This is very noticeable if the coke used for charging retorts after scaling is tested on discharge. Similarly coke discharged from retorts which have been standing at a holiday period is relatively unreactive. High throughputs are impossible with heavy steaming and a low calorific value. For the same declared C.V. coke can be more reactive when benzole extraction is practised, on account of the higher throughputs that can be worked.

The Author has advocated the allocation of different coals to different types of carbonizing plant, with a view to obtaining a proportion of high reactive coke for open fires. This practice can even be extended to the allocation of low rank coals to certain retorts or ranges where a works has only continuous verticals. This procedure was adopted at the Windsor Street works of the Birmingham Gas Department many years ago, and domestic and industrial coke treated separately on the screening plants. Such practice requires either steady day-to-day deliveries of each type of coal, or, alternatively, substantial storage hopper accommodation for the different types of coal. Unfortunately, since the commencement of the war, regular daily deliveries of each type of coal have been upset by the system of block train working, which means that weekly consignments of coal from a particular colliery are confined to perhaps two trains per week, and if this system continues (and it has many advantages from the point of view of railway working) it may be desirable on new plants to provide considerably increased coal hopper storage.

The Author stresses the difficulty of disposing of breeze and states that the use of breeze below ⅜ in. for boiler firing is far from satisfactory. In Birmingham, however, a design of Babcock & Wilcox water tube boiler with chain grate stoker has been installed which burns this fuel with complete satisfaction.

Gas Research Board's Investigation

Dr. **J. G. King** (Director, Gas Research Board) wrote:—Mr. Gardiner has produced a very good survey of the various factors



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affecting the properties of coke, whose adequate control might achieve practical improvements. It is a very obvious truth that if industry could be supplied with really clean coal, most of the troubles would disappear. The Tottenham experiment on clean coal referred to indicates the advantages even during carbonization, and markedly during gasification to water gas. In outside applications the benefits would be even more marked. In British coals, the average content of inherent ash is 3.5 to 4%. There seems to be no reason why the mining industry should not supply suitable coals at this level as soon as the present industrial difficulties have been overcome.

Mr. Gardiner has referred to the Gas Research Board's proposal to explore thoroughly all the effects of really clean coal. It would seem, however, that we must still wait for some time before we can start those valuable experiments. The question of reactivity of the coke is a difficult one. It is true that in some carbonizing systems, coals of relatively low carbon content give more reactive cokes than the coking coals of high carbon content, but it is an unfortunate fact that the higher the reactivity of these lower carbon coals, the lower the bulk density of the resulting cokes. The exact meaning of reactivity has not been established, and it does seem to me that more fundamental work on this question is called for. Such work might give a lead as to how the coal might be treated during carbonization, or the coke thereafter, to give that reactivity to oxygen which is necessary. It is an interesting fact that in the gasification of coal in hydrogen under pressure, coke is produced with an abnormally high reactivity to oxygen, although the temperature during gasification had exceeded 1,000° C. My explanation is that the volatile matter was driven off under conditions which avoided the deposition of carbon, and which therefore left the surface of the coke completely clean. This may also explain the good quality of the coke which Mr. Bamber has obtained by circulating water gas during carbonization in continuous vertical retorts. Such results give a lead to more fundamental work.

The introduction of dry-cooling plants in the Gas Industry has hitherto been prevented by high capital charges and maintenance costs. It is perhaps possible that greater control of the properties of the finished coke might discount these purely monetary disadvantages?

Mr. Gardiner has made out a strong case for adequate cutting and grading of coke. In the work done on the manufacture of producer fuel, careful attention to cutting gave a yield of graded fuel as high as 90% of the original coke. I feel that engineering research could design coke-cutting machinery which would give equally high yields of industrial coke. This proposal, as well as the proposal to examine the difference in properties between natural and cut grades of coke, is also on the programme of the Gas Research Board, and will be undertaken when facilities and staff are available.

The Obvious Raw Material

Dr. R. Lessing (London) wrote:—Mr. Gardiner has performed a useful task by his survey of the main factors which determine the quality of coke. He has rightly stressed that the burning characteristics of coke depend primarily on the properties of the coal from which it is made. I would go further by insisting that coal, whatever its geographical origin, must be regarded as a heterogeneous mixture of at least four distinct components and that it is these components which, under otherwise equal conditions, individually or in combination determine the kind of coke made. One of these components of coal as mined and as marketed is the extraneous mineral matter which forms the great bulk of the ash left on burning coal or coke. I need hardly reiterate my views on the vital need for the complete removal of this portion in the course of coal preparation. The experimental facts obtained in the Tottenham tests speak for themselves. They were set out in the paper read at the Institution meeting in 1931 from which Mr. Gardiner quotes, and in Colonel H. C. Smith's Presidential Address to the Southern District Association in the same year. But, removing ash-forming matter from the coal, although it is a *sine qua non*, does not go far enough. It is of almost equal importance that in the course of that preparation the other three components should be separated from each other and each directed into that form of utilization to which it is best suited.

These components are (1) the dust naturally occurring in coal as mined; (2) the caking portion, usually bright and of low specific gravity, and having an ash content not exceeding 3%; and (3) the non-caking or feebly caking dull portion, of medium gravity with an ash content of 6-12%. I have discussed the principles underlying this scheme and its impact on all forms of coal utilization in a Paper read before the Institute of Fuel in September, 1943 (unfortunately published in abridged form), and only wish to emphasize that the second component, bright coal, is the obvious raw material for the carbonizing industries. The dust should be applied to pulverized fuel firing, and the dull component as fuel for boilers and furnaces in general. The technical problems of separation have been solved and proved in practice, and only await application on the widest possible scale.

For gas-works purposes I regard the removal of dust as of nearly the same importance as the removal of ash-forming minerals. The remarkable difference in quantity and quality of breeze made from original and clean coal are largely due to the presence or absence of natural coal dust, but I also ascribe the great reduction in time of carbonizing clean coal and the enhanced rate of gasification in making water gas from the clean coke, in large measure to the absence of dust. By its removal, clogging of interstices is prevented and the smooth surfaces of particles permit a rapid passage of gas and tar.

My endeavours during the last 20 years to persuade gas undertakings to adopt my proposals did not meet with success. It is, therefore, gratifying to learn from the Paper that the Gas Research Board has adopted the suggestion which I submitted to the Committee of Enquiry on Coke Quality that a clean coal should be tested on a works scale for 12 months in different types of carbonizing plant. It is hoped that in formulating their programme for this work, the Gas Research Board will define clean coal on the lines now adumbrated.

Having dealt with the pre-requisite of supplying the carbonizing process with the right kind of raw material, I must refer to the problem of modifying the burning quality of coke by the addition of chemicals. When mentioning the researches of Marson and Cobb, the Author was obviously unaware of the work which preceded it and from which it derived its inspiration. In their papers presented to the Institution meeting in 1925, Marson and Cobb gave a useful historical review of the earlier work, and duly acknowledged my contributions to the conception and investigation of the influence of ash constituents and of added inorganic compounds on the carbonizing mechanism. I mention this not to claim priority, due credit having been given to this, but with a view to inducing those in control of carbonizing research to resume work on the lines I indicated and with now existing facilities for development which were not available to me. I am convinced that activation of coke will never be feasible on a really large scale if it involves the complication of a special plant and process at the gas-works subsequent to carbonization. To be successful the addition of catalysts should be incorporated in the process of preparation of gas coal which can be done in a very simple manner and without the need for special plant.

Author's Reply

Mr. P. C. Gardiner, in reply to the discussion, wrote:—In this Paper I have endeavoured to draw attention to the difficulties brought about by the conflicting interests of coke and gas production in gas-works, with the object of inducing members to give their views on this aspect of gas manufacture, and I wish to thank all those who have contributed to the discussion, which was most gratifying.

First of all, I hasten to assure Colonel H. C. Smith that it is no part of my policy to retain old-fashioned coal grates in use, if and when more modern appliances are available and can be fitted at economic prices. My advocacy of the use of a light reactive coke in existing coal grates is primarily intended as a means of carrying over for the next ten years or so, by which time it is hoped that special coke grates will be in general use, at any rate in new houses.

Even then, the more reactive coke will be an advantage in the new grates as well as in those old-fashioned grates which may still be in use in the older houses.

Although there was a rapid development of the special coke grate before the war, these grates were largely installed in the better-class property. The vast future expansion of the solid smokeless fuel market must now be into the lower income classes who are, in the main, users of raw coal. If the production of a fuel suitable for existing grates proves impossible of achievement then the Industry may be forced to finance the provision of special coke grates on terms similar, perhaps, to those on which cookers are supplied to prepayment gas consumers.

Another handicap is that the fitting of coke grates in old houses is usually both more difficult and more costly than their installation in new buildings.

The true comparative values of "clean" and "uncleaned" coal are most difficult to ascertain and that is why a re-examination of the problem is advocated.

Colonel Smith is quite right in stating that the Tottenham balance sheet of the results of the test carried out in 1930 indicated that gas made from "clean" coal was rather more expensive than that made from the original slack; but the Clean Coal Company's figures based on the assumption that the coal was cleaned at the colliery showed that the gas from "clean" coal was slightly cheaper, and it is agreed that the proper place for the cleaning plant is at the colliery where the coal is mined.

Mr. F. B. Richards referred to the conflicting interests of gas and coke production which are very real and constitute a major difficulty in carbonizing practice. The quality of coal which produces gas most economically, rarely, if ever, gives the best coke when gauged by the standards of the domestic fuel requirements. On more than one occasion in the course of the Paper it is emphasized that the procedure in most works amounts of necessity to a series of compromises.

The removal of the ash at the colliery is accepted as the ideal procedure and moreover it will generally be necessary for each colliery to do its own cleaning. There is a very serious objection to a central cleaning plant, owing to the extreme difficulty in keeping the different grades of coal separate, a course which is essential in order that advantage may be taken of the special characteristics of each. Mr. Richards also referred to the difficulties inherent in breeze blending, which are acknowledged, but it has been demonstrated that fine breeze can be blended back with the coal quite successfully. The realization of this idea is largely dependent upon the ability to separate the fines below (say) ¼ in or $\frac{1}{16}$ in., and screen makers assert that this can be done.

(To be concluded)

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September 3.

From July 15 there has been an increase of 5s. per ton in the price fixed by the Coal Tar Controller for Coal Tar Pitch in bulk or solid form for the manufacture of Patent Fuel in the home market.

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Average prices of gas-works products: Pitch, 70s. per ton; toluole, naked, North, 90's, 2s. 4d. to 2s. 6¾d. per gallon; pure, 3s. 2¼d. Prices for carbolic acid 60's, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil are controlled by Government Orders. Prices for road tar were increased by a half-penny per gallon by S. R. & O. 1945, 229, under which Order there was also an increase of 5s. per ton in the price for standard creosote-pitch mixture.

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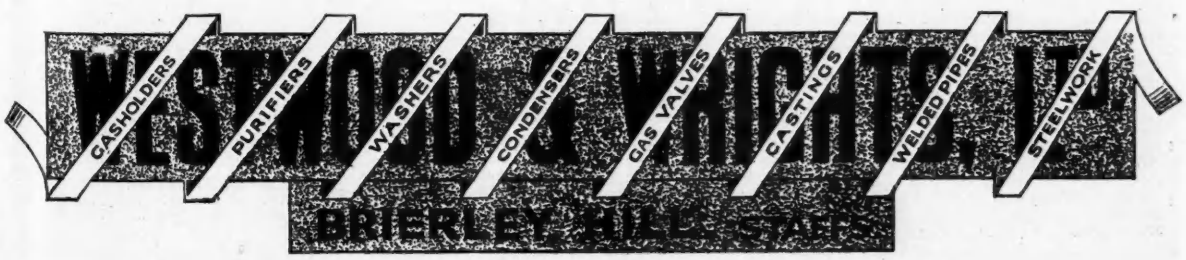
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